Energy Surveys of Army Dining Facilities

Fort Sill, Oklahoma

FINAL REPORT

Prepared For:

Department of the Army

U.S. Army Corps of Engineers
Tulsa District

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I. EXECUTIVE SUMMARY

A. Concept of the Study

The purpose of this study is to survey the Dining Facilities as well as all energy using equipment within these facilities at Fort Sill and identify energy conservation potential within these areas. As part of this study, all programming documentation has been developed to obtain funding for these projects.

B. Scope of Work

1) This project has accomplished an energy survey at 40 dining facilities at Fort Sill, Oklahoma. Twenty-two of these are permanent dining facilities and the remaining 18 are temporary buildings.

A full energy audit was performed on 9 permanent dining facilities as listed in the scope. This audit concentrates on each of the areas of energy usage within the facility and identifies consumption estimates based on usage patterns and equipment size. This information allows for the development of tables and graphs indicating energy consumption on a monthly basis for use in directing the contractor to areas where the greatest impact on consumption and therefore savings can be realized.

An energy study was performed on the remaining 13 permanent dining facilities. This study realizes the similarity in these buildings and those in which a full energy audit has been performed. With this information, energy conservation opportunities (ECOs) can be developed for each facility including all cost estimating forms, savings estimates, and other supporting documentation required.

A limited survey on 18 temporary dining facilities has been accomplished. This survey is directed toward all low cost/no cost recommendations with a simple payback not to exceed 4 years.

2) Buildings Surveyed

Buildings requiring a full energy audit as listed in the scope are:

Facility No.	Facility No.
914	3415
1603	3440
1653	6007
2437	6011
2811	

Permanent buildings requiring an energy study:

Facility No.	Facility No.
912	3424
913	3426
1490	3428
3413	5030
3417	5684
3419	6050
3422	

Temporary buildings receiving a limited energy survey:

Facility No.	Facility No.
2591	4367
2633	4388
3660	4407
3721	4421
3730	4451
3737	4458
3758	4460
4358	4467
4360	4481

In total, this represents approximately 221,000 square feet of heated or cooled floor area.

3) Equipment Surveyed

Identification of energy conservation opportunities(ECOs) requires a working knowledge of the equipment within the facility. To this end, the following equipment was surveyed to determine its functional use, operating hours, control system and operational parameters:

Chillers
Boilers
Pumps
Air Handling Units
Window Unit Air Conditioners
Unit Heaters
Water Heaters
Cooking Equipment
Walk in Freezers
Dishwashers
Refrigeration Equipment
Domestic Water Pumps
Lighting Systems

4) Night Setback/EMCS

At the time of this study, Energy Masters Inc. was conducting a design analysis on a central energy management and control system (EMCS) at Fort Sill. The EMCS as planned will provide automatic on/off control of AHUs, pumps, space cooling and heating equipment. There is some question as to the actual time frame that will be required to get the EMCS operational.

Currently, most of the HVAC equipment serving the dining facilities operate continuously. In many of these cases, air handlers for the dining facilities were found tied in with a night setback timeclock which controlled all air handlers within the building. Since the dining areas realize different operational periods from adjacent barracks areas, the timeclock was generally found disabled. Funds have been included under ECO 15 - Night Setback/Thermostats to install a separate timeclock for air handlers serving the dining facility. In some cases, this should allow the existing timeclock to be used for the remaining areas. Due to the fast payback of these systems, the savings obtained before the EMCS is installed will more than offset the cost of local equipment installed. Several features have been recommended for these setback systems to allow for maximum setback periods while still allowing for operational flexibility. These include spring-wound or battery backup for power outages, low limit thermostat for freeze protection and a timed over-ride switch to allow for unscheduled operation. While these features will also decreasae the maintenance required by the setback system, periodic maintenance of the systems will still be necessary.

C. Recommendations

1) Options Investigated

Figures 1 and 1A identify the 52 various energy conservation opportunities (ECOs) that have been investigated for each of the buildings. Care was exercised when taking into account synergism (overlapping savings) between ECOs and an effort has been made to determine the true incremental savings of each ECO. Recommended projects are marked with an "X".

2) Modifications For Energy Conservation

A major program of ECOs is recommended as depicted in Figures 1 and 1A. Table 1 provides a summary by ECO of those projects recommmended for implementation. This ECO package when implemented will result in a savings of approximately 60000 MBTU(s) per year. At present utility costs, this represents an annual savings of approximately $256,780. The total cost of these projects is approximately $788,000 yielding an average payback of 3.1 years and a savings-to-investment ratio of 4.4.

Figure 2 indicates a summary of the baseline energy consumption for the 9 permanent facilities requiring a full energy audit. Figure 3 provides annual energy usage after implementation of the ECOs for these facilities. Figure 4 details the savings consumption for these same facilities.

The baseline energy consumption estimates for the nine permanent facilities were extrapolated out to estimate the total baseline consumption for all the buildings included in this study at 172,400 MBTUs. The recommended projects will reduce this consumption by approximately 60,000 MBTUs or 35% when implemented.

ECOS INVESTIGATED																																	
Building Numbers	1) Insulation	2) Insulated Glass	3) Weatherstrip/Caulk	4) Solar Films	5) Attic Venting	6) Vestibules	7) Large Door Seals	8) Reduction of Glass Area	9) Shutdown HWH/Mod Controls	10) Energy Eff. Lighting	11) Reduce Light Levels	12) Replace Incandescent Lights	13) Improve PF in HVAC & R	14) Inst. Hi-Eff. Motors	15) Night Setback/Thermostats	16) Infrared Heaters	17) Economizer Cycles (Dry Bulb)	18) Heat Reclaim Kitchen Exhaust	19) Radiator Controls	20) Heat Reclaim (Refr. Gas)	21) Reduce HVAC Air Flow	22) Revise Boiler Controls	23) Heat Recov. Dishwasher HW	24) Booster Heater & HW User	25) Lower Domestic HW Temp.	26) Water Treat/Soften	27) Transformers	28) Upgrade HVAC Controls	29) Make HVAC Operations Eff.	30) HVAC Zones	31) Optimize Dining Operations	32) Balance HVAC System
912		X	X								X	X			X								X			X							
913			X								X	X			X								X			X							
914			X								X												X			X				X			
1490											X	X			X								X			X				X			
1603B											X	X											X			X				X			
1653											X	X			X					X			X			X				X			
2437		X	X					X			X	X			X								X			X		X		X			
2591																																	
2633											X				X								X										
2811						X					X	X								X			X			X							
3413			X			X					X				X								X			X				X			
3415			X			X					X				X								X							X			
3417			X								X				X								X			X				X			
3419			X								X	X			X								X			X							
3422			X								X	X			X								X			X							
3424			X								X	X			X								X			X							
3426			X								X	X			X								X			X							
3428			X								X	X			X								X			X							
3440			X								X				X								X			X							
3660		X	X									X			X																		
3721			X								X	X			X																		
3730			X								X	X			X																		
3737			X								X	X			X																		
3758			X								X	X			X																		
4358			X								X	X			X																		
4360			X								X	X			X																		
4367			X								X	X			X																		
4388			X								X	X			X																		
4407			X								X	X			X																		
4421			X								X	X			X																		
4451			X								X	X			X																		
4458			X								X	X			X																		
4460			X								X	X			X																		
4467			X								X	X			X																		
4481			X								X	X			X																		
5030		X	X								X													X		X							
5684			X					X			X	X			X									X		X		X		X			
6007											X				X									X		X							
6011			X								X	X			X						X			X		X					X		
6050											X				X		X							X		X							

FIGURE 1

ECO S INVESTIGATED

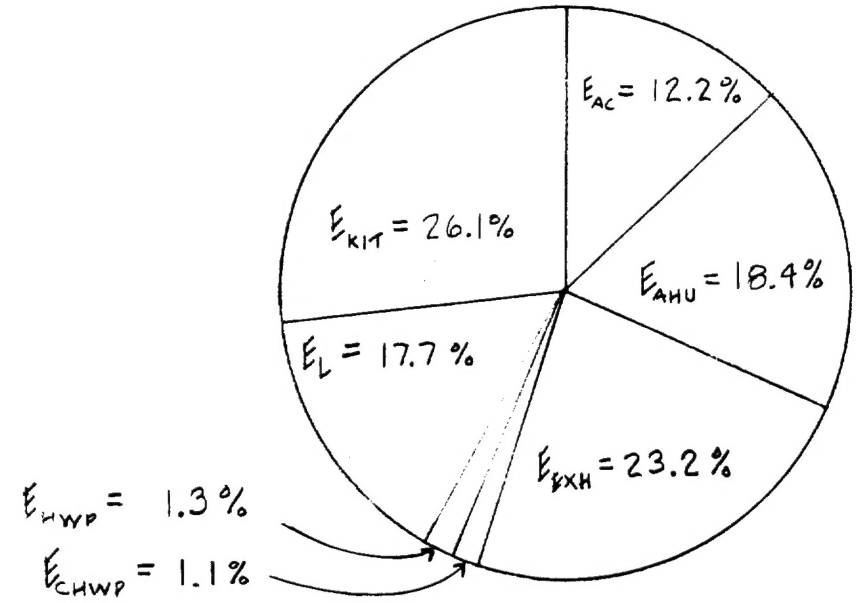
Building Numbers	33) Change to VAV System	34) Ceiling Fans	35) Air Curt. @ Entrances	36) Heat Pumps HW/AC	37) Make-Up Air for Kitchen	38) Shut Range Hood Exh. System	39) Utilize Available Steam	40) Separate AC/AHU	41) HVAC Ducting/Dampers	42) Waste Heat Recovery	43) Reduce OSA/Exhaust	44) Timers for Fans	45) Reduce MZ Damper Leakage	46) Duty Cycling	47) Piping Insulation	48) Optimize Pumping	49) DHW Circulation Pump Timer	50) EMCS	51) Deck Temp. - MZ & DD	52) Increase Area Light Switch.	53) Timed Switches	54) Solar Water Heater	55) Steam/Water Leaks
912				X								X		X									
913	X			X								X											
914	X			X							X	X		X									
1490				X								X		X									
1603B	X			X								X		X									
1653				X								X											
2437				X								X		X	X	X	X						
2591																							
2633												X											
2811				X							X	X		X									
3413				X								X		X	X								
3415				X							X	X		X	X								
3417				X					X		X	X		X	X								
3419				X					X			X		X	X					X			
3422				X					X		X	X		X	X					X			
3424				X					X		X	X		X	X								
3426				X					X			X		X	X								
3428				X					X			X		X	X								
3440				X					X		X	X		X	X								
3660												X											
3721												X											
3730												X			X								
3737												X			X								
3758												X											
4358												X											
4360												X			X								
4367												X											
4388									X			X			X								
4407												X			X								
4421												X			X								
4451												X			X								
4458												X											
4460												X											
4467												X			X								
4481												X			X								
5030	X			X							X	X											
5684				X								X		X		X	X						
6007				X					X		X	X											
6011				X								X		X							X		
6050				X							X	X											

FIGURE 1A

FORT SILL TOTAL ECO SUMMARY

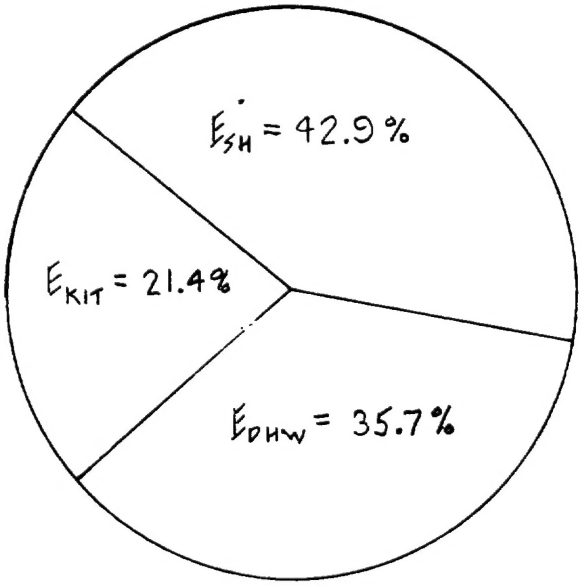
ECO	DESCRIPTION	ELEC MBTU	GAS MBTU	TOTAL MBTU	SAVINGS DOLLARS	ECO COSTS	SIR	PAY BACK
31	OPTIMIZE DINING OPERATIONS	349.7	598.1	947.8	3901	3810	21.4	1.0
47	PIPING INSULATION	0.0	684.5	684.5	3236	5139	14.8	1.6
44	TIMERS FOR FANS	9396.8	8633.2	18030.0	69588	67509	13.5	1.0
41	HVAC DUCTING/DAMPERS	55.0	30.0	85.0	308	373	10.3	1.2
15	NIGHT SETBACK/THERMOSTATS	3812.0	4242.8	8054.8	31728	42734	9.9	1.3
53	TIMED SWITCHES	424.4	-88.3	336.1	881	1110	7.9	1.3
23	HEAT RECOVERY DISHWASHER HW	-154.5	11933.3	11778.8	51627	163921	7.7	3.2
3	WEATHERSTRIP/CAULK	156.5	558.0	714.5	3121	11058	6.2	3.5
48	OPTIMIZE PUMPING	249.0	98.0	347.0	1225	2594	5.7	2.1
28	UPGRADE HVAC CONTROLS	0.0	77.0	77.0	363	1000	5.5	2.8
43	REDUCE OSA/EXHAUST	586.0	888.0	1474.0	5997	18926	4.3	3.2
49	DHW CIRCULATION PUMP TIMER	95.0	0.0	95.0	291	810	3.7	2.8
46	DUTY CYCLING	2260.1	1011.3	3271.4	11700	38962	3.7	3.3
11	REDUCE LIGHT LEVELS	6023.3	-1141.7	4881.6	13028	39580	3.4	3.0
12	REPLACE INCANDESCENT LIGHTS	4069.0	-701.3	3367.7	9131	34749	2.9	3.8
20	HEAT RECLAIM (REFR. GAS)	0.0	516.4	516.4	2442	20943	2.7	8.6
36	HEAT PUMPS HW/AC	-7358.5	10295.9	2937.4	23054	179428	1.6	7.8
2	INSULATED GLASS	5.0	78.0	83.0	383	3886	2.3	10.1
26	WATER TREAT/SOFTEN	0.0	370.5	370.5	18118	81170	2.2	4.5
8	REDUCTION OF GLASS AREAS	253.2	246.0	499.2	1939	21485	1.8	11.1
52	INCREASE AREA LIGHT SWITCHING	20.0	0.0	20.0	61	526	1.7	8.6
17	ECONOMIZER CYCLES (DRY BULB)	13.0	0.0	13.0	40	320	1.3	8.0
6	VESTIBULES	25.0	146.0	171.0	770	13590	1.3	17.6
33	CHANGE TO VAV SYSTEM	1003.5	169.1	1172.6	3848	34061	1.3	8.9
TOTAL		21283.5	38644.8	59928.3	256780	787684	4.4	3.1

TABLE 1



BREAKDOWN OF BASELINE ELECTRIC CONSUMPTION

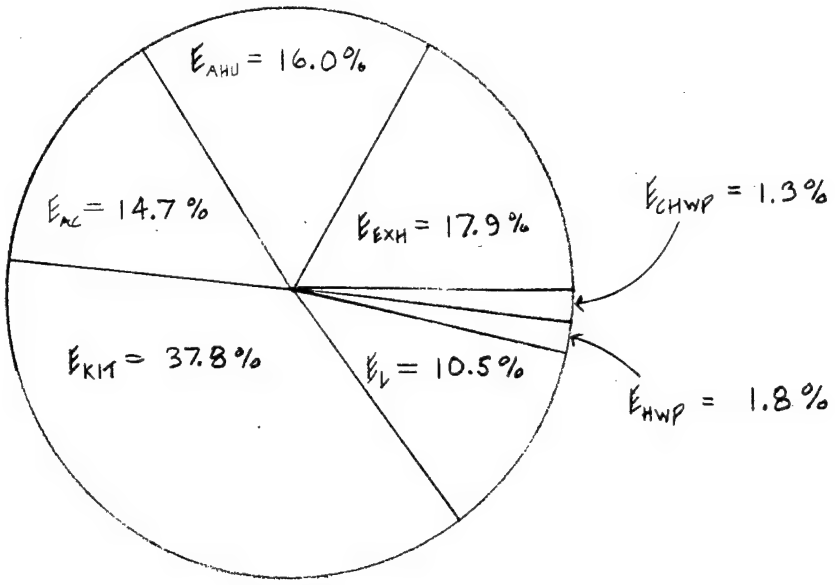
TOTAL ELECTRIC CONSUMPTION = 37705.8 MBTU(S) = $115,380
(FOR NINE FULL AUDIT FACILITIES)



BREAKDOWN OF BASELINE GAS CONSUMPTION

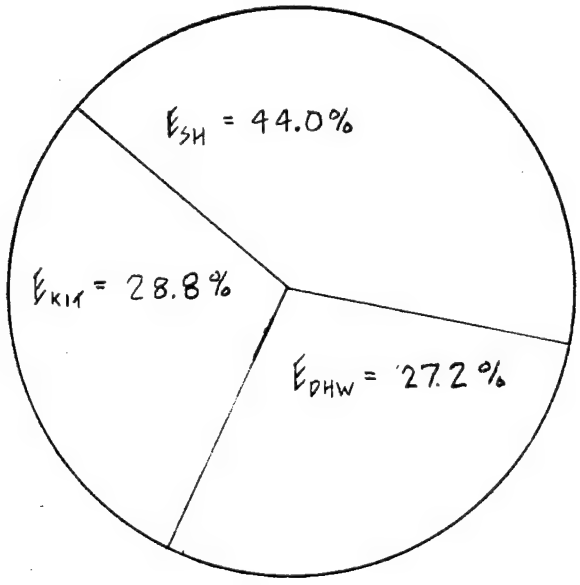
TOTAL GAS CONSUMPTION = 43806.9 MBTU(S) = $ 207,207
(FOR NINE FULL AUDIT FACILITIES)

- FIGURE 2 -



BREAKDOWN OF NEW ELECTRIC CONSUMPTION

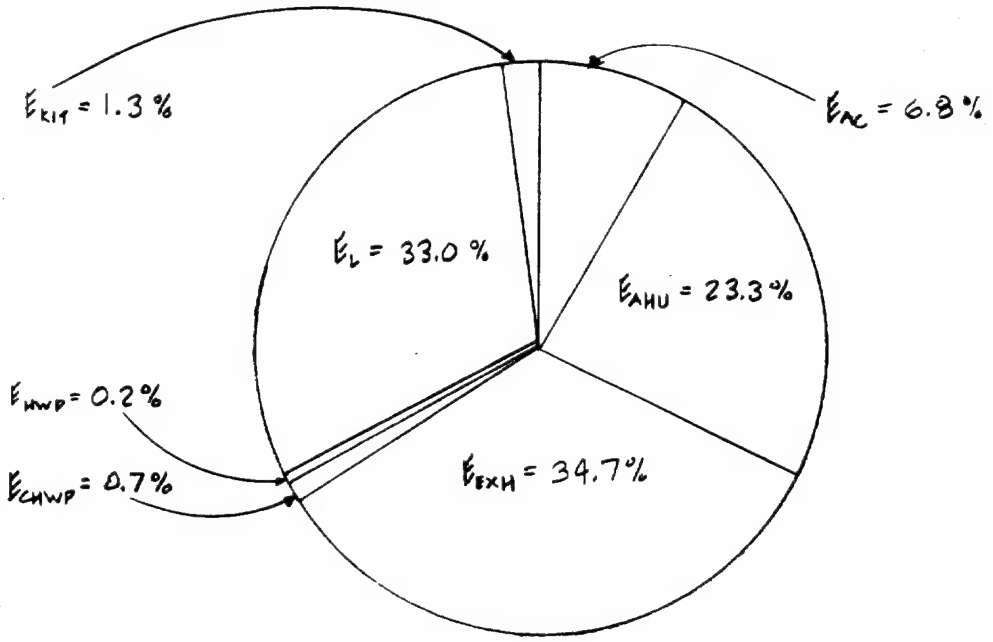
TOTAL ELECTRIC CONSUMPTION = 25664.3 MBTU(S) = $ 78,533
(FOR NINE FULL AUDIT FACILITIES)



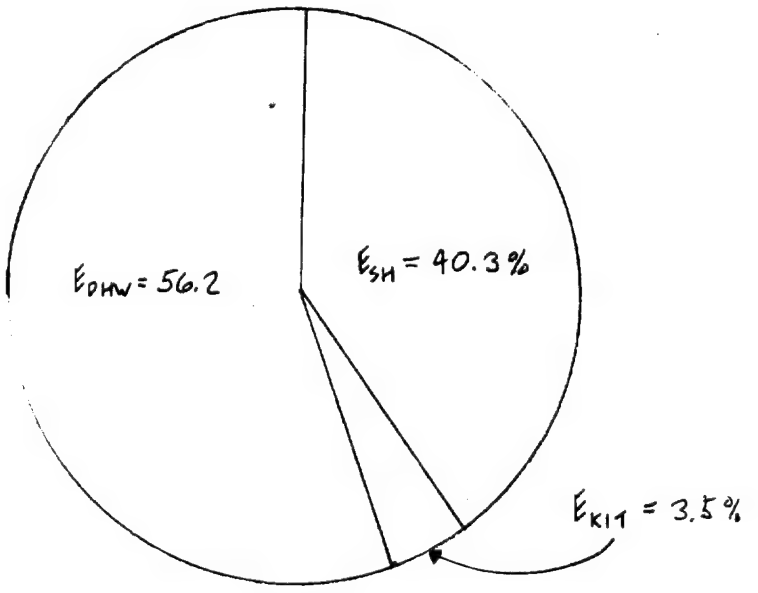
BREAKDOWN OF NEW GAS CONSUMPTION

TOTAL GAS CONSUMPTION = 31072.3 MBTU(S) = $ 146,972
(FOR NINE FULL AUDIT FACILITIES)

- FIGURE 3 -



BREAKDOWN OF ANNUAL ELECTRIC SAVINGS
TOTAL ELECTRIC SAVINGS = 12041.5 MBTU(S) = $ 36,847
(FOR NINE FULL AUDIT FACILITIES)



BREAKDOWN OF ANNUAL GAS SAVINGS
TOTAL GAS SAVINGS = 12734.6 MBTU(S) = $ 60,235
(FOR NINE FULL AUDIT FACILITIES)

-FIGURE 4-

3) Projects Developed

The ECOs have been grouped into 12 major projects. These are as follows:

Project 1: To be funded by the Activity.

Includes: ECO 31 - Optimize dining operations

Construction Cost $3810 (FY85)

Annual Savings:

Electricity	349.7 MBTU(s)	$1072
Natural Gas	598.1 MBTU(s)	$2829
Total	947.8 MBTU(s)	$3901

SIR: 21.4 Payback: 1.0 Years
Analyzed: October 1984

Project 2: To be funded by the Activity.

Includes: ECO 3 - Weatherstrip/caulk
ECO 6 - Vestibules
ECO 47 - Piping Insulation
Construction Cost $29787 (FY85)

Annual Savings:

Electricity	181.5 (MBTU(s)	$ 559
Natural Gas	1388.5 (MBTU(s)	$6568
Total	1570.0 (MBTU(s)	$7127

SIR: 5.4 Payback: 4.2 Years
Analyzed: October 1984

Project 3: To be funded by the Activity.

Includes: ECO 23 - Heat Recovery Dishwasher H.W.

Construction Cost $163,921 (FY85)

Annual Savings:

Electricity	-154.5 MBTU(s)	$-1581
Natural Gas	11933.3 MBTU(s)	$56445
Total	11778.8 MBTU(s)	$54864
Increased Maintenance		$3237
Net Annual Savings		$51627

SIR: 7.7 Payback: 3.2 Years
Analyzed: October 1984

Project 4: To be funded by the Activity.

Includes: ECO 17 - Econ. Cycle (Dry Bulb)
ECO 28 - Upgrade HVAC Controls
ECO 41 - HVAC Ducting/Dampers
ECO 43 - Reduce OSA/Exhaust

Construction Cost $20619 (FY85)

Annual Savings:

Electricity	654.0 MBTU(s)	$2002
Natural Gas	995.0 MBTU(s)	$4706
Total	1649.0 MBTU(s)	$6708

SIR: 4.4 Payback: 3.1 Years
Analyzed: October 1984

Project 5: To be funded by the Activity.

Includes: ECO 46 - Duty Cycling

Construction Cost $38962 (FY85)

Annual Savings:

Electricity	2260.1 MBTU(s)	$ 6917
Natural Gas	1011.3 MBTU(s)	$ 4783
Total	3271.4 MBTU(s)	$11700

SIR: 3.7 Payback: 3.3 Years
Analyzed: October 1984

Project 6: To be funded by the Activity.

Includes: ECO 11 - Reduce Light Levels
ECO 12 - Replace Inc. Lights
ECO 52 - Increase Area Light Switching
ECO 53 - Timed Switches

Construction Cost $75965 (FY85)

Annual Savings:

Electricity	10536.7 MBTU(s)	$32237
Natural Gas	-1931.3 MBTU(s)	$-9136
Total	8605.4 MBTU(s)	$23101

SIR: 3.2 Payback: 3.3
Analyzed: October 1984

Project 7: To be funded by the Activity.

Includes: ECO 2 - Insulated Glass
ECO 8 - Reduction of Glass Area

Construction Cost $25371 (FY85)

Annual Savings:

Electricity	258.2 MBTU(s)	$ 789
Natural Gas	324.0 MBTU(s)	$1533
Total	582.2 MBTU(s)	$2322

SIR: 1.9 Payback: 10.9 Years
Analyzed: October 1984

Project 8: To be funded by the Activity.

Includes: ECO 33 - Change to VAV System

Construction Cost $34061 (FY85)

Annual Savings:

Electricity	1003.5 MBTU(s)	$3048
Natural Gas	169.1 MBTU(s)	$800
Total	1172.6 MBTU(s)	$3848

SIR: 1.3 Payback: 8.9 Years
Analyzed: October 1984

Project 9: To be funded by the Activity.

Includes: ECO 26 - Water Treat/Soften

Construction Cost $81170 (FY85)

Annual Savings:

Electricity	0	MBTU(s)	$ 0
Natural Gas	370.5	MBTU(s)	$ 1755
Total	370.5	MBTU(s)	$ 1755
Maintenance Reduction			$15563
Net Annual Savings			$18118

SIR: 2.2 Payback: 4.5 Years
Analyzed: October 1984

Project 10: QRIP Project

Includes: ECO 44 - Timers for Fans

Construction Cost $67509 (FY85)

Annual Savings:

Electricity	9396.8	MBTU(s)	$ 28753
Natural Gas	8633.2	MBTU(s)	$ 40835
Total	18030.0	MBTU(s)	$ 69588

SIR: 13.5 Payback: 1.0 Years
Analyzed: October 1984

Project 11: QRIP Project

Includes: ECO 15 - Night Setback/Thermostats
ECO 48 - Optimize Pumping
ECO 49 - DHW Circulation Pump Timer

Construction Cost $46138 (FY85)

Annual Savings:

Electricity	4156.0	MBTU(s)	$12712
Natural Gas	4340.8	MBTU(s)	$20532
Total	8496.8	MBTU(s)	$33244

SIR: 9.5 Payback: 1.4 Years
Analyzed: October 1984

Project 12: ECIP Project

Includes: ECO 20 - Heat Reclaim (Refr. Gas)
ECO 36 - Heat Pumps HW/AC

Construction Cost $231630 (FY85)
$251200 (FY87)

Annual Savings:

Electricity	7358.5 MBTU(s)	$-22520
Natural Gas	10812.3 MBTU(s)	$51142
Total	3453.8 MBTU(s)	$28622
Increased Maintenance		$3126
Net Savings		$25496

SIR: 1.7 Payback: 7.9 Years
Analyzed: October 1984

These projects include all ECOs as recommended in this report.

Table 2 provides the total savings and economics for these projects.

PROJECTS SUMMARY

ECO	DESCRIPTION	ELEC MBTU	GAS MBTU	TOTAL MBTU	SAVINGS DOLLARS	ECO COSTS	SIR	PAY BACK
1	OPTIMIZE DINING OPERATIONS	349.7	598.1	947.8	3901	3810	21.4	1.0
2	BUILDING SHELL MODIFICATIONS	181.5	1388.5	1570.0	7127	29787	5.4	4.2
3	HEAT RECOV. DISHWASHER H.W.	-154.5	11933.3	11778.8	51627	163921	7.7	3.2
4	AIR SYSTEM MODIFICATIONS	654.0	995.0	1649.0	6708	20619	4.4	3.1
5	DUTY CYCLING	2260.1	1011.3	3271.4	11700	38962	3.7	3.3
6	LIGHTING MODIFICATIONS	10536.7	-1931.3	8605.4	23101	75965	3.2	3.3
7	WINDOW SYSTEM MODIFICATIONS	258.2	324.0	582.2	2322	25371	1.9	10.9
8	CHANGE TO VAV SYSTEM	1003.5	169.1	1172.6	3848	34061	1.3	8.9
9	WATER TREAT/SOFTEN	0.0	370.5	370.5	18118	81170	2.2	4.5
10	TIMERS FOR FANS	9396.8	8633.2	18030.0	69588	67509	13.5	1.0
11	SETBACK	4156.0	4340.8	8496.8	33244	46138	9.5	1.4
12	HEAT RECOVERY/HEAT PUMPS	-7358.5	10812.3	3453.8	25496	200371	1.7	7.9
TOTAL		21283.5	38644.8	59928.3	256780	787684	4.4	3.1

TABLE 2